

APPENDIX I: Ethical Issues Relevant to OBPR Research and Space Flight

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The nature, goal and purpose of the crew.

The science on the ISS is done at this time by a human crew: simultaneously vulnerable, brave and limited by their embodiment. The ReMAP committee was confronted with this reality as a central feature of our work, and this defined many of our discussions of first priorities. One of the leading ethical issues we confronted was the seriousness of the risks that the crew faces in space.

The crew can be understood as functioning in three ways, and for each role, intrinsic rights, duties and obligations for the crew and for the surrounding community--we who send them into space on our behalf---changes.

First, they are *researchers* for the scientific projects, running the science experiments, checking on the plants and animals, recording their observations and readings of the complex phenomena, and maintaining the equipment that sustains the research. In this way, they are similar to other scientists who work in extreme earth environments, such as Antarctica or volcanoes, who do their science at the risk of serious harm, or even death. We understand that such research is in part the work of particular careers in science, undertaken voluntarily, and with the assumption that risk is a feature of such investigation.

Second, the crews are *human subjects* in what is similar to classic Phase One clinical trials on how the human body reacts to microgravity, and to long term confinement in the harsh and precarious environment of space. (We on earth are the control arm of such trials) As subjects of research, they need the full range of protects of such subjects, privacy, autonomy, and informed consent. We hope by our use of the subjects to learn better how to address both medical problems on earth, and how to address the medical problems to be solved in space for future crews. Like all Phase One trials, it is unlikely that initial research can benefit the first subjects. Like all research, it can be highly risk-laden, and can result in serious harm, so much so that NIH research commonly have Data Safety Monitoring Boards to monitor adverse incidents, harm, and death, and stop human trials if they become too dangerous. Like all such research, participation is completely voluntary.

Third, the crews are *public servants*, voluntarily undertaking a task that is difficult, highly risky and technically demanding. In this way the crew need workplace protections, similar in nature to how we protect *soldiers, police and firefighters*. Here too, persons are workers who may face the risk of serious harm or death. We assume in these cases (and the case of both NYPD and NYFD and of soldiers at war as we wrote the document) that high risk activity is a necessary component of a voluntary occupation, taken on in the name of duty, love of country and service.

Finally, they are *explorers*, privileged to take on extraordinary challenges in the name of discovery. For many on the ReMAP Task Force, this last description was the most compelling. Our ethical obligations to the crew can be mapped very differently based on how we regard the crew. Such activities have also been a classic part of all exploration, and in this, we understood the task of Lewis and Clark--part science, part military statecraft, and part commercial--as paradigmatic. Since much of the science is prioritized in order to avoid "show stoppers" (things which would terminate a mission or harm the crew). For an example, the ranking of scientific research in fire safety becomes named as a high priority for this reason.

The needs of the crew for external rescue should something go awry are the single clearest constraint on the size of the crew. A crew return vehicle only holds three persons. Much of the science proposed cannot be done with only three crewmembers. This only deepens the problem of assessing the cost/benefit analysis of good science, and the need to decide what level of risk to the crew is an acceptable level of risk. There can be no situation of zero risk--hence, what is at stake is how much risk for harm can be named as acceptable, as assessment which varies depending on how you understand the crew as scientists, subjects or soldiers. Risk level assessment drives the science priorities, for the concept of "show stoppers" became the drivers for some of the highest priorities of science. We were moved to ask: who should assess the nature of risk? How can full consent be protected? How can we clearly understand the risk as public citizens who fund and support the work? What risks are acceptable, and what unacceptable (even if the crew might wish to take them) to the larger polity?

Animal experimentation in space

International codes of law and norms of research using human subjects insist on the use of animal models for research prior to human research. In this, separate issues of the animals on board the space crafts and the station carry separate ethical challenges, an issue given great consideration by the agency. In light of the Nuremberg and Helsinki accords for research, full animal research and its facilities, and all that this implies for animal habitat and animal care, would seem to be necessitated if we intend to use humans in space. Hence, one of the priorities that was named as essential was based on this ethical norm. Animal habitats that support model organisms act as proof of principle for humans.